TECHNICAL REPORT NO 200

# AN ANALYSIS OF CONTENT AND TASK DIMENSIONS OF LANGUAGE ARTS ITEMS DESIGNED TO MEASURE LEVEL OF CONCEPT ATTAINMENT

REPORT FROM THE PROJECT ON A STRUCTURE OF CONCEPT ATTAINMENT ABILITIES

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR
COGNITIVE LEARNING



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# AN ANALYSIS OF CONTENT AND TASK DIMENSIONS OF LANGUAGE ARTS ITEMS DESIGNED TO MEASURE LEVEL OF CONCEPT ATTAINMENT

By
Margaret L. Harris and Lester S. Golub

Report from the Project on
A Structure of Concept Attainment Abilities

Robert E. Davidson, Lester S. Golub, Herbert J. Klausmeier,
Thomas A. Romberg, B. Robert Tabachnick, Alan M. Voelker
Principal Investigators

and

The Quality Verification Program
Mary R. Quilling, Director

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

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## Statement of Focus

The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Project on the Structure of Concept Attainment Abilities in Program 1. The general objectives of this project are to identify basic concepts in language arts, mathematics, science, and social studies appropriate at a given grade level; to develop tests to measure achievement of these concepts; and to develop and identify reference tests for cognitive abilities. These will be used to study the relationships among learned concepts in various subject matter areas, cognitive abilities, and possibly, certain cognitive styles. The results of these will be a formulation of a model of structure of abilities in concept attainment.

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## Abstract

Content and task dimensions of language arts items were studied using factor analytic techniques. These items were developed to measure concept attainment using a completely crossed design with 30 concepts and 12 tasks. Conventional factor analyses were performed, separately for boys and girls, for concept scores and for task scores. Three-mode factor analyses were performed.

The main conclusions drawn from the results of the conventional factor analyses are that all 30 of the concepts are measures of a single functional relationship existing among the concepts, and that all 12 tasks are measures of a single underlying ability or latent trait. The three-mode results indicate that there are no important concept-task interactions for the idealized persons; thus it is reasonable to regard the concepts and the tasks as being two independent modes.

# I
# Introduction

The primary objective of the project entitled "A Structure of Concept Attainment Abilities" (hereafter referred to as the CAA Project) is to formulate one or more models or structures of concept attainment abilities, and to assess their consistency with actual data. The major steps for attaining this primary objective were taken to be:

1. To identify basic concepts in language arts, mathematics, science, and social studies appropriate at the fourth grade level,
2. To develop tests to measure achievement of these concepts,
3. To identify reference tests for cognitive abilities, and
4. To study the relationships among learned concepts in these four subject matter fields and the identified cognitive abilities.

This paper contains a report of the factor analytic study of the content and task dimensions of the language arts items that were developed as one aspect of Step 2. This study is a necessary intermediate step between Step 2 and Step 4; some reduction in the number of concepts for each subject matter field from the 30 selected ones for which tests were developed is mandatory in order to be able to carry out Step 4.

## Nature of Language Arts Items

Concepts may be defined in one or more of four ways: (a) structurally, in terms of perceptible or readily specifiable properties or attributes; (b) semantically, in terms of synonyms or antonyms; (c) operationally, in terms of the procedures employed to distinguish the concept from other concepts; or (d) axiomatically, in terms of logical or numerical relationships (Klausmeier, Harris, Davis, Schwenn, & Frayer, 1968). "A concept exists whenever two or more distinguishable objects or events have been grouped or classified together and set apart from objects on the basis of some common feature or property of each" (Bourne, 1966, p. 1). The concept of Bourne's definition might be called a classificatory one and seems to be the same as the structural type discussed by Klausmeier et al. (1968). This is the type of concept with which this project is concerned, and such a definition of a concept served as the basis for selection and analysis of subject matter concepts.

Many different types of performance might be taken as the critical evidence that a student does or does not understand a given concept. Thus, as a part of this project it is necessary to have a schema for measuring understanding of concepts. Such a schema was developed by Frayer, Fredrick, and Klausmeier (1969) and was used by the CAA Project to assess concept attainment. The "Schema for Testing the Level of Concept Mastery" consists of 13 types of questions, each involving a different task required of the examinee. The schema also allows for selection of an answer (multiple-choice type questions) or for production of an answer (completion type questions). It was decided to use the first 12 tasks and a multiple-choice format for this project. The 12 tasks of the schema which were used are:

1. Given the name of an attribute, select an example of the attribute.
2. Given an example of an attribute, select the name of the attribute.
3. Given the name of a concept, select an example of the concept.
4. Given the name of a concept,

select a nonexample of the concept.
5. Given an example of a concept, select the name of the concept.
6. Given the name of a concept, select the relevant attribute.
7. Given the name of a concept, select the irrelevant attribute.
8. Given the definition of a concept, select the name of the concept.
9. Given the name of a concept, select the definition of the concept.
10. Given the name of a concept, select the supraordinate concept.
11. Given the name of a concept, select the subordinate concept.
12. Given the names of two concepts, select the relationship between them.

Single- or compound-word classificatory concepts (those that are defined by attributes) in language arts subject matter at the fourth grade level were identified. This task was subdivided into four steps:

1. Identification of the major areas within the subject matter of language arts,
2. Selection of three of these major areas to be studied,
3. Identification of classificatory concepts within each of these three major areas, and
4. Random sampling of ten concepts from those identified for each of the three major selected areas.

This yielded a total of 30 language arts concepts to be studied by the project. A list is given in Table 1, by area, of the concepts identified and randomly selected for study. The areas are Words, Words in Sentences, and Connected Discourse. A description of the procedures used to identify these concepts can be found in "Selection and Analysis of Language Arts Concepts for Inclusion in Tests of Concept Attainment" (Golub, Fredrick, Nelson, & Frayer, 1971).

The researchers of Project 101, Situational Variables and Efficiency of Concept Learning, developed a system for analyzing a concept in preparation for developing items to measure the level of attainment of that concept (Frayer, Fredrick, & Klausmeier, 1969). Since the publication of that paper they, in cooperation with the researchers of the CAA Project, have refined their thinking and advanced this system. The refinements are discussed in "A Structure of Concept Attainment Abilities: The Problem and Strategies for Attacking It" (Harris, Harris, Frayer, & Quilling, in press). Briefly, a concept may be described in many ways: in terms of its criterial, relevant, and irrelevant attributes; its examples and nonexamples; its supraordinate, coordinate, and subordinate hierarchical relationships (theoretically determined); and its lawful or other types of relationships to other concepts. Knowledge of each of these kinds of information may be tested to determine a student's level of attainment of a concept. An analysis, along these lines, of each of the 30 sampled language arts concepts which are being studied can be found in "Selection and Analysis of Language Arts Concepts for Inclusion in Tests of Concept Attainment" (Golub, Fredrick, Nelson, & Frayer, 1971).

Thus, using the analysis of a concept as the basis for appropriate content and the 12 tasks of the schema as the basis for appropriate tasks, 12 items, one for each of the 12 tasks, could be developed for each of the 30 concepts making a total of 360 language arts items. Actually, only 355 items were developed for the purpose of measuring and assessing concept attainment in language arts, as no subordinate concept was identified for five of the concepts: Explanation, Heading, Paragraph, Return Address, and Thank You Letter. Thus, there is no Task 11 item for these concepts. A description of the procedures used in the development of these items, along with item and total score statistics (for concepts and for tasks) obtained for them for beginning sixth grade boys and girls, can be found in "Measuring Language Arts Concept Attainment: Boys and Girls" (Golub, Fredrick, & Harris, in press). The items can be found in "Items to Test Level of Attainment of Language Arts Concepts by Intermediate-Grade Children" (Golub, Fredrick, & Nelson, 1971).

The following sections contain a discussion of the study of the dimensionality of the two modes, concepts (content) and tasks, of this completely crossed design used to develop items to measure concept attainment in language arts.

## Hypothesized Factor Structures

Alternative sets of factors were postulated for the language arts concepts and for the tasks using language arts content by viewing the concepts and tasks as two independent modes. Viewing them in this way is essentially hypothesizing that no important interactions exist between the two modes.

Table 1. Language Arts Concepts Categorized by Area

| Area I: Words | Area II: Words in Sentences | Area III: Connected Discourse |
|---|---|---|
| *abbreviation | *adjective | body |
| antonym | adverb | business letter |
| apostrophe | capital letter | closing |
| *compound word | colon | *comparison |
| *consonant | comma | conclusion |
| consonant blend | command | description |
| *contraction | common noun | *detail |
| *homonym | connector | envelope |
| hyphen | determiner | example |
| long vowel | exclamation | *explanation |
| meaning | exclamation mark | *greeting |
| prefix | forms of *be* | *heading |
| rhyme | forms of *have* | indentation |
| root word | *helping verb | inside address |
| *short vowel | main verb | invitation |
| *silent letter | modifier | mailing address |
| specific word | negative | main idea |
| *suffix | noun | narration |
| syllable | past tense | order of ideas |
| *synonym | *period | *paragraph |
| vowel | plural noun | poetry |
| *word | *possessive noun | quotation |
| | *predicate | *return address |
| | preposition | signature |
| | *present tense | social letter |
| | *pronoun | story |
| | proper noun | supporting sentence |
| | question | *thank you letter |
| | *question mark | theme |
| | regular verb | *title |
| | request | *topic sentence |
| | *sentence | |
| | singular noun | |
| | statement | |
| | subject | |
| | tense | |
| | *verb | |

*Concepts that were selected for testing.

## Concepts

The most general hypothesis is that just one common factor underlies the selected language arts concepts. Next in the order of generality to specificity is that three common factors are present, one for each of the three major areas selected for study: Words, Words in Sentences, and Connected Discourse. A more specific hypothesis is that there may be two or more common factors for each of the three areas. A structure of the concepts within each of the three areas was not hypothesized. Instead, it was preferred to randomly sample concepts from each area and see what functional relationships exist among those sampled concepts. It was felt that this would eliminate bias in the picture of the dimensionality of the concepts imposed by theoretical relationships that may or may not exist in actuality. If attainment of concepts is highly specific, this approach may be detrimental as there may

not be at least two measures (concepts) of a concept dimension included. There are some indications that the concepts are not this specific. For example, fairly reliable task scores obtained by totalling across the 30 concepts for a single task were obtained. This indicates some degree of homogeneity among the concepts.

## Tasks

The most general hypothesis is that just one common factor or ability underlies the 12 tasks. A more specific hypothesis is that there are five underlying abilities: an ability dealing with attributes (Tasks 1 and 2); one dealing with examples of a concept (Tasks 3, 4, and 5); one related to the definition of a concept (Tasks 6, 7, 8, and 9); one related to hierarchical relationships (Tasks 10 and 11); and one for a relationship of a concept with another concept (Task 12). A slightly more specific hypothesis is that there are six abilities: the five just listed, with the exception that the ability related to the definition of a concept may be further specific to those tasks dealing with relevant and irrelevant attributes (Tasks 6 and 7) and those tasks dealing directly with a definition (Tasks 8 and 9).

These alternative sets of factors represent an *a priori* analysis of the language arts concepts and the tasks when using language arts content. A major question to be answered in this study is the extent to which the obtained factors parallel such hypothesized analyses. Note that, as discussed, several levels of specificity are postulated. Another question to be answered in this study is the extent to which the concepts and the tasks are independent as hypothesized.

# II
# Procedures

## Subjects

Pilot studies revealed that the concepts selected were very difficult for fourth graders. Thus, the decision was made to test fifth grade students with the concepts identified and sampled from the fourth grade textbooks. The language arts items were administered to 186 boys and 259 girls who were just beginning the sixth grade during the fall of 1970 in the public school system of Madison, Wisconsin. The subjects were students who volunteered to participate as a result of a letter sent to a random sample from the population of all such boys and from the population of all such girls. Approximately 60% of those invited to participate in the testing responded affirmatively. The subjects who completed the testing program were paid $7.50.

Since the participation of all students comprising the random sample was impossible to attain, test score and IQ data were obtained from the files of the Madison Public School System for those students for whom the information was available. Table 2 includes the summary statistics for the population of fifth grade students in the public school system of the city of Madison during the school year 1969-70, and for the boys and the girls who comprised the tested samples for the language arts items. The Lorge-Thorndike Intelligence scores were obtained in the fall of 1968 when the subjects were fourth graders, and the scores on the Iowa Tests of Basic Skills, given in grade equivalent scores, were obtained in the fall of 1969 when the subjects were fifth graders.

Data on fathers' occupations were collected from the students using the Master Occupational Code of the United States Bureau of the Census. These data were tabulated and are presented in Table 3.

## Data Collection

The data were collected during five 2-hour testing sessions from mid-October to early November. Since a large percentage of sixth graders attended one of three middle schools, it was decided to test the selected students from those schools in their own buildings after school hours. The sixth grade students attending various elementary schools were tested on three consecutive Saturday mornings at centrally-located schools. Each 2-hour session consisted of a 71-item "test" composed of language arts items, a 72-item "test" composed of science items, and an activity break between the two. The language arts and the science items were given first on alternate days.

The language arts items were arranged in five 71-item "tests." The order of the items was assigned randomly over the potential 360 items. Two different random orders were used to collect the data: one for each type of school for both boys and girls. The items were arranged in five test booklets according to the random order. The students responded to each item by marking their chosen response directly on an answer sheet. The answer sheets were read by machine and the responses punched onto data cards. The tests were given by experienced test administrators to groups of approximately 30 subjects each.

## Treatment of the Data

The treatment of the data consisted of two main procedures: reliability estimation and factor analysis. The data were analyzed separately for each sample. Hoyt analysis of variance reliability estimates were obtained for each of the 30 concept scores and each

Table 2. Test Data for Population and Samples

| Test | | Population | Boys | Girls |
|---|---|---|---|---|
| Lorge-Thorndike Intelligence | $\bar{X}$ | 106.60 | 106.11 | 112.23 |
| | s | | 14.82 | 13.37 |
| | N | 2605 | 161 | 239 |
| Iowa Basic Skills | | | | |
| Vocabulary | $\bar{X}$ | 5.53 | 5.54 | 5.88 |
| | s | | 1.41 | 1.33 |
| | N | 2520 | 181 | 246 |
| Reading Comprehension | $\bar{X}$ | 5.44 | 5.29 | 5.97 |
| | s | | 1.51 | 1.35 |
| | N | 2520 | 181 | 247 |
| Language Skills | $\bar{X}$ | 5.24 | 5.04 | 5.82 |
| | s | | 1.44 | 1.34 |
| | N | 2520 | 181 | 248 |
| Work-Study Skills | $\bar{X}$ | 5.46 | 5.41 | 5.86 |
| | s | | 1.30 | 1.18 |
| | N | 2520 | 181 | 248 |
| Arithmetic Skills | $\bar{X}$ | 5.05 | 5.08 | 5.35 |
| | s | | .96 | 1.00 |
| | N | 2520 | 181 | 247 |
| Composite | $\bar{X}$ | 5.35 | 5.27 | 5.77 |
| | s | | 1.17 | 1.11 |
| | N | 2520 | 181 | 245 |

CONCEPTS

| | Area 1<br>1 2 . . . . . 10 | Area 2<br>11 12 . . . . . 20 | Area 3<br>21 22 . . . . . 30 | Total Score for Tasks |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| . | | | | |
| 12 | | | | |
| Total Score for Concepts | | | | |

Fig. 1. Item matrix for each individual.

Table 3. Distribution of Fathers' Occupations

| | Girls | Boys |
|---|---|---|
| 00. Accountant | 4 | 7 |
| 01. Architect | 3 | 2 |
| 02. Dentist | 3 | 1 |
| 03. Engineer | 10 | 7 |
| 04. Lawyer, Judge | 6 | 2 |
| 05. Clergyman | -- | 3 |
| 06. Doctor | 12 | 3 |
| 07. Nurse | -- | -- |
| 08. Teacher, Professor | 20 | 15 |
| 09. Other Professional | 26 | 15 |
| 11. Farmer | -- | -- |
| 21. Owner of Business | 4 | 2 |
| 22. Manager, Official | 28 | 13 |
| 31. Bookkeeper | -- | -- |
| 32. Receptionist | 1 | -- |
| 39. Other Clerical | 6 | 4 |
| 49. Salesman | 27 | 24 |
| 51. Craftsman, Skilled Worker | 39 | 22 |
| 52. Foreman | -- | 2 |
| 53. Armed Services - Officer | -- | 1 |
| 54. Armed Services - Enlisted | -- | 1 |
| 61. Truck Driver | 5 | 4 |
| 62. Operative in Factory | 16 | 11 |
| 69. Other Operative | 12 | 12 |
| 71. Fireman | 2 | 2 |
| 72. Policeman | 2 | 4 |
| 73. Other Protective Service | 3 | -- |
| 74. Practical Nurse, Nurse's Aide | 1 | 1 |
| 75. Private Household Worker | -- | -- |
| 79. Other Service Workers | 14 | 16 |
| 81. Non-farm Laborer | 3 | 2 |
| 82. Farm Laborer | 1 | -- |
| 91. Not presently in labor force | 6 | 6 |
| 99. Not ascertained | 12 | 10 |

of the 12 task scores for each group studied. Means and standard deviations for each of the scores were also computed.

## Factor Analysis

Developing one item for each of the 12 tasks for each of the 30 selected concepts yields a 12 (tasks) by 30 (concepts) matrix consisting of the score for each of the 360 items, one for each cell of the matrix, for each individual to whom the items are administered. A completely crossed design exists and two types of total scores can be secured from this matrix: a total score for each of the 30 concepts (totalled across tasks) and a total score for each of the 12 tasks (totalled across concepts). Figure 1 is an illustration of such a matrix. Using this design to test concept attainment yields data of a three-dimensional type, if more than one concept and more than one task are included. The three dimensions are concepts, tasks, and individuals. The application of conventional factor analysis procedures to such data presents certain problems. As it has been used in the past, the researcher commonly collapses one dimension of the data, thereby losing information that is possibly very important. For example, common practice would be to use mean scores over the set of individuals to create a two-dimensional concept by task matrix which is then "factored."

Tucker's (1966a, 1966b) three-mode factor analysis has made it possible to factor analyze three-dimensional data without the potential

loss of information involved in collapsing a dimension. There are some problems, however, in applying the analysis to data collected using the concept by task design with one item per cell. First, the data for a three-mode system are 0-1 data with a single item per cell; thus, there is a reliability problem with single item variables. Second, the common factors in the system are of major interest and the program to which there is access is for a component type analysis. Third, as in ordinary factor analysis, the question of the number of factors (components) to extract is a difficult question to answer, and this information has to be input into the three-mode program. For these reasons the procedures outlined here were used for factor analyzing the language arts data collected using the schema for testing level of concept attainment.

Briefly, the strategy consists of performing conventional factor analyses separately for the concepts and for the tasks to gain some insight into the interrelationships among the variables of a single mode. Tucker's three-mode factor analysis was then used to determine if there are any important concept-task interactions for the idealized persons (person components).

*Conventional factor analyses.* The original plans called for determining the comparable common factors, separately for the concepts and for the tasks, by using a strategy suggested by Harris and Harris (1970). This strategy is a way to determine those factors that are robust with respect to method—factors which tend to include the same variables across methods. Analyses were obtained using three initial factor methods: Alpha (Kaiser & Caffrey, 1965), Harris R-$S^2$ (Harris, 1962), and Unrestricted Maximum Likelihood Factor Analysis (UMLFA) (Jöreskog, 1967). These three methods provide a factor solution with a statistical basis with the number of factors determined by a statistical test (UMLFA), and two factor solutions with a psychometric basis: one for a relatively small number of factors (Alpha) and one for a relatively large number of factors (Harris R-$S^2$). All three of the methods are independent of the scale of the variables. Derived orthogonal solutions were obtained for each of the three initial solutions using the Kaiser normal varimax procedure (Kaiser, 1958), and derived oblique solutions were obtained using the Harris-Kaiser independent cluster solution (Harris & Kaiser, 1964).

The "right number of factors" question is one for which there is still no definitive answer. For matrices which yield about the same number of factors when different methods are used, Harris and Harris (1970) suggest taking the comparable common factors as the substantive results. Doing this, the number of factors can be more or fewer than the number of factors for any single solution. This idea does not seem to be appropriate when the number of common factors obtained using different methods varies considerably, as is the case, for example, with the factoring of the language arts concepts: for boys and girls respectively, 1 and 2 for Alpha, 7 and 8 for Harris R-$S^2$, and 3 and 4 for UMLFA for the derived orthogonal solutions; the derived oblique solutions yielded 1 and 2 for Alpha, 6 each for Harris R-$S^2$, and 3 and 4 for UMLFA for boys and girls respectively. These results will be presented more explicitly and discussed in the next section.

Alpha sometimes underfactors, and underfactoring is, according to Kaiser, "an unforgivable sin." Harris R-$S^2$ extracts a relatively large number of factors (Kaiser calls it deliberate overfactoring); but this is no problem since derived orthogonal common factors retain the important things, get rid of the "garbage," and are in no way substantially affected by doing so (Kaiser, 1970). As an example, for the language arts concepts, Harris R-$S^2$ extracted 17 factors initially for both the boys and the girls but the derived orthogonal solution trimmed these to 7 common factors for boys and 8 for girls. Kaiser (1970) advocates this "deliberate overfactoring" but says he wishes oblique transformations were robust to it which they are not. This problem was "solved" by not submitting the initial raw factor matrix to oblique rotation. Instead, the common factors of the derived orthogonal solution were taken as F and used to build $R^*$. The Q obtained from a principal axes decomposition of $R^*$ then was submitted for oblique transformation. Thus: derived orthogonal common factors = F; $FF' = R^*$; $R^* = QD^2Q'$; and then this Q is transformed to give an oblique solution. It may be pointed out here that getting derived oblique factors from the initial raw factor matrix or from the Q obtained from $R^*$ will not make any difference if the number of initial factors and the number of derived orthogonal common factors is the same; this is the case for the factors obtained for the language arts concepts and tasks using both Alpha and UMLFA. Incidentally, Kaiser (1970) in the same paper advocates obtaining "Harris factors" as they are *model-free*. What is named Harris R-$S^2$ is one of the set of "Harris factors."

This discussion of the number of factors

is an important one for this paper since it is necessary to input the number of factors for concepts and the number of factors for tasks into the three-mode program. For these language arts data the number of factors used was the number of Harris R-S$^2$ derived oblique common factors. The main reason for this is that Harris R-S$^2$ gives as many or more common factors as Alpha or UMLFA and greater specificity should allow any concept-task interactions to be more demonstrable.

*Three-mode factor analyses.* As was mentioned earlier in the paper, three-mode factor analyses (Tucker, 1966a, 1966b) were performed to determine if there are any important concept-task interactions for the idealized persons. Three problems were mentioned at that time. Two of them were "solved" by doing the conventional factor analyses. The common factors in each of the two modes, concepts and tasks, were obtained and the number of factors (components) to input into the three-mode program for the two modes other than individuals was determined. The third problem still remains—the reliability problem with single item variables consisting of 0-1 type data. Also, a fourth problem exists which should perhaps be pointed out at this time. There are some missing data as can be seen from looking at Table 4; instead of 360 items, there are only 355. And empty cells cannot be tolerated in a three-mode factor analysis. To alleviate the latter two problems mentioned, single item unreliability and missing data, a three-mode analysis was performed on two different forms of the same data in an attempt to gain insight into the existence of any important concept-task interactions. It might also be pointed out that the existing program has the capacity to handle only a product of 120 for the two modes other than individuals. Thus, we could not analyze our 30 concepts by 12 tasks, as this gives a product of 360. It would have been possible to expand the program's capacity to some extent but it would have been very difficult, if not impossible, to expand it to handle a product of 360.

Conceptually, the 30 concepts were organized by subject matter experts into three areas within the subject matter field. A three-mode analysis was conducted using only three variables for concepts. Each of these variables is a composite of the items for a single task across the ten concepts within a single area. Thus, the input data for this analysis consisted of a 3 (concepts) by 12 (tasks) matrix of 36 entries for each individual. Each entry consisted of the total number correct of ten items (or fewer in the cases of missing data). The number of factors (components) for concepts input for this analysis was taken as three. The number of factors (components) for tasks input for this analysis was the number of derived oblique factors obtained for the Harris R-S$^2$ method—three each for boys and girls. This analysis will be referred to as Type I three-mode analysis. Such an analysis should permit any task interactions to be clearly evident, as each task is a separate entry; actually, each task comprises three separate entries, one for each composite concept variable.

A second three-mode analysis, to be referred to as Type II, was conducted using all 30 of the concepts but only three task variables. The task variables are composites of the items for a single concept for given tasks. The composites formed for boys are:

Task Variable A - Tasks 1, 2, and 3
Task Variable B - Tasks 4, 5, 8, 10, and 11
Task Variable C - Tasks 6, 7, 9, and 12

The composites formed for girls are:

Task Variable A - Tasks 1, 2, 3, and 6
Task Variable B - Task 4
Task Variable C - Tasks 5, 7, 8, 9, 10, 11, and 12

The formation of the composites was based on the derived oblique factors obtained for the Harris R-S$^2$ method. A task was assigned to a composite on the basis of its highest factor coefficient. It is realized that this is essentially forming factor scores using a rather undesirable method, but it was felt that since the intercorrelations of the task factors are very high (in fact so high that a reasonable interpretation is that the 12 tasks are all measures of the same latent ability), it would not be too detrimental. Also, it provided a way of forming composites based on experimental results rather than theoretical considerations to allow for greater specificity; an alternative would have been to input only one variable for tasks which would consist of a composite for all 12 of the tasks. Thus, the input data for this Type II three-mode analysis consisted of a 30 (concepts) by 3 (tasks) matrix of 90 entries for each individual. Each entry for the boys consisted of the total number correct of three, five, or four items (or fewer in the cases of missing data) and each entry for the girls consisted of the total number answered correctly of four, one, and seven items (or fewer in the cases of missing data). The number of factors (components) for tasks input for

this analysis was taken as three. The number of factors (components) for concepts input for this analysis was the number of derived oblique factors obtained for the Harris R-$S^2$ method—six for both boys and girls. Such an analysis should permit any concept interactions to be clearly evident since each concept is a separate entry; actually, each concept comprises three separate entries, one for each composite task variable. There still may be somewhat of an unreliability problem in this analysis, as one of the entries for girls consists of the score for just one item.

The results of treating the data in these various ways are presented and discussed in the following section.

# III
# Results and Discussion

The means, standard deviations, and Hoyt reliability estimates obtained for the data collected during the fall of 1970 using the language arts items developed are presented, separately for boys and girls, for total concept and total task scores. The intercorrelations and factor results for these data are presented and discussed, once again separately for boys and girls.

## Reliability Estimates and Test Statistics

Tables 4 and 5 contain the means, standard deviations, and Hoyt reliability estimates obtained for the data collected during fall, 1970, using the revised items for total concept and total task scores. The data were analyzed separately for the 186 boys and the 259 girls. In general, the concept scores consist of 12 items each, and the task scores of 30 items each. Exceptions to this are noted on the tables.

The mean scores for boys are approximately one-half of a standard deviation lower than are the mean scores for girls for both total concept and total task scores. Thus, on these language arts items the girls performed better than did the boys. A ranking of the tasks from easiest to most difficult is the same for both boys and girls. This consistency does not hold for the concepts, however; both boys and girls found the items for the concepts in the area Words to be the easiest and the items for the concepts in the area Words in Sentences to be the most difficult.

The reliability estimates are very similar for boys and girls. For the task scores they are in the .70s and .80s; for the concept scores they are generally in the .60s and .70s with a few falling outside of this range. It is to be expected that the task scores are more reliable than the concept scores since the task scores are based on 30 items while the concept scores are based on only 12 items.

The reliability estimates are sufficiently high to warrant study of the dimensionality of these selected language arts concepts and the tasks when using language arts content. This is a major objective of the CAA Project and is the main purpose for developing these items to measure language arts concept attainment.

## Factor Analyses

The correlation matrices for the concept scores upon which the factor analyses were based are given in Table 6 for boys and Table 7 for girls. The intercorrelations for the task scores are given in Table 8 for boys and Table 9 for girls.

The intercorrelations of the concept scores are quite consistent in magnitude within the matrix for both boys and girls. The correlations are in the .50s to .70s with the exception of the concept Heading which is generally in the .40s for both boys and girls. Looking at the reliability estimates obtained for the concept scores reveals that they range from .47 to .80 for boys and .52 to .80 for girls; they are typically in the .50s to .70s. Thus, if the correlations were corrected for attenuation they would all be very high. The lower correlations obtained are almost wholly associated with the concept scores which have low reliability estimates.

The intercorrelations of the task scores are quite consistent in magnitude for boys and girls. They are mostly in the .80s with those in the .70s being almost entirely for Tasks 7, 11, and 12. Once again, it is interesting to look at the reliability estimates for the task scores. They are typically in the

Table 4. Means, Standard Deviations, and Reliability Estimates for Language Arts Concept Scores: Boys and Girls

| No. | Concept | Boys ($N$ = 186) Mean | S.D. | Hoyt Rel. | Girls ($N$ = 259) Mean | S.D. | Hoyt Rel. |
|---|---|---|---|---|---|---|---|
| 1 | Abbreviation | 6.8 | 2.8 | .71 | 8.4 | 2.6 | .72 |
| 2 | Compound Word | 6.8 | 2.7 | .69 | 8.5 | 2.5 | .70 |
| 3 | Consonant | 7.3 | 2.6 | .67 | 8.4 | 2.4 | .68 |
| 4 | Contraction | 6.2 | 2.9 | .73 | 7.6 | 3.0 | .77 |
| 5 | Homonym | 6.8 | 2.7 | .69 | 8.3 | 2.5 | .69 |
| 6 | Short Vowel | 7.5 | 2.9 | .76 | 8.6 | 2.7 | .75 |
| 7 | Silent Letter | 7.4 | 2.8 | .70 | 9.0 | 2.6 | .74 |
| 8 | Suffix | 6.0 | 3.3 | .80 | 7.2 | 3.3 | .80 |
| 9 | Synonym | 6.1 | 2.8 | .68 | 7.6 | 2.7 | .70 |
| 10 | Word | 6.8 | 2.8 | .71 | 8.0 | 2.6 | .70 |
| 11 | Adjective | 4.6 | 2.6 | .65 | 5.5 | 2.9 | .72 |
| 12 | Helping Verb | 4.9 | 2.2 | .47 | 5.7 | 2.3 | .52 |
| 13 | Period | 7.0 | 2.7 | .67 | 8.5 | 2.4 | .68 |
| 14 | Possessive Noun | 5.8 | 2.7 | .67 | 6.9 | 2.7 | .69 |
| 15 | Predicate | 5.1 | 2.7 | .67 | 6.3 | 3.0 | .74 |
| 16 | Present Tense | 6.0 | 2.7 | .68 | 7.1 | 2.7 | .72 |
| 17 | Pronoun | 5.5 | 2.7 | .66 | 6.5 | 2.8 | .72 |
| 18 | Question Mark | 7.9 | 2.9 | .76 | 9.6 | 2.5 | .77 |
| 19 | Sentence | 6.9 | 2.9 | .72 | 8.7 | 2.7 | .75 |
| 20 | Verb | 6.3 | 2.8 | .69 | 7.1 | 2.9 | .75 |
| 21 | Comparison | 6.2 | 2.9 | .72 | 7.4 | 2.8 | .72 |
| 22 | Details | 6.1 | 2.7 | .68 | 7.3 | 2.8 | .73 |
| 23[a] | Explanation | 6.0 (6.5) | 2.7 | .70 | 6.7 (7.3) | 2.7 | .72 |
| 24 | Greeting | 6.7 | 2.6 | .67 | 8.0 | 2.4 | .67 |
| 25[a] | Heading | 4.9 (5.3) | 2.3 | .59 | 5.9 (6.4) | 2.5 | .69 |
| 26[a] | Paragraph | 6.5 (7.1) | 2.7 | .71 | 7.7 (8.4) | 2.6 | .75 |
| 27[a] | Return Address | 6.9 (7.5) | 2.3 | .64 | 8.1 (8.8) | 2.0 | .57 |
| 28[a] | Thank You Letter | 7.2 (7.8) | 2.7 | .74 | 8.6 (9.4) | 2.3 | .73 |
| 29 | Title | 7.2 | 2.9 | .73 | 8.7 | 2.4 | .68 |
| 30 | Topic Sentence | 5.1 | 2.4 | .58 | 6.4 | 2.7 | .67 |

[a] Denotes concepts tested by 11 items rather than 12. These concepts did not have appropriate subordinates as required in Task 11. The numbers in parentheses are extrapolations based on 12 items.

Table 5. Means, Standard Deviations, and Reliability Estimates for Language Arts Task Scores: Boys and Girls

| Task No. | No. of Items | Boys ($N$ = 186) Mean | S.D. | Hoyt Rel. | Girls ($N$ = 259) Mean | S.D. | Hoyt Rel. |
|---|---|---|---|---|---|---|---|
| 1 | 30 | 19.4 | 6.3 | .87 | 23.1 | 5.3 | .86 |
| 2 | 30 | 17.2 | 6.3 | .86 | 20.7 | 5.7 | .85 |
| 3 | 30 | 18.0 | 5.9 | .84 | 21.4 | 5.2 | .83 |
| 4 | 30 | 18.0 | 5.4 | .80 | 21.0 | 5.3 | .82 |
| 5 | 30 | 16.6 | 6.1 | .84 | 19.8 | 5.4 | .83 |
| 6 | 30 | 15.4 | 6.3 | .85 | 19.0 | 6.3 | .86 |
| 7 | 30 | 14.4 | 5.2 | .75 | 16.8 | 5.3 | .78 |
| 8 | 30 | 15.6 | 7.0 | .88 | 19.3 | 6.8 | .89 |
| 9 | 30 | 16.3 | 6.6 | .87 | 19.5 | 6.4 | .87 |
| 10 | 30 | 16.1 | 6.3 | .85 | 19.4 | 6.0 | .86 |
| 11[a] | 25 (30) | 11.4 (13.7) | 4.3 | .72 | 13.5 (16.2) | 4.4 | .75 |
| 12 | 30 | 12.3 | 5.2 | .78 | 15.1 | 5.7 | .82 |

| Task No. | Task Description |
|---|---|
| 1 | Given name of attribute, select example. |
| 2 | Given example of attribute, select name. |
| 3 | Given name of concept, select example. |
| 4 | Given name of concept, select nonexample. |
| 5 | Given example of concept, select name. |
| 6 | Given concept, select relevant attribute. |
| 7 | Given concept, select irrelevant attribute. |
| 8 | Given definition of concept, select name. |
| 9 | Given name of concept, select definition. |
| 10 | Given concept, select supraordinate concept. |
| 11[a] | Given concept, select subordinate concept. |
| 12 | Given two concepts, select relationship. |

[a]Five concepts did not possess appropriate subordinates. The numbers in parentheses are extrapolations based on 30 items.

Table 6. Intercorrelations of Language Arts Concepts: Boys[a]

| Concept | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 65 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 62 | 68 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 65 | 67 | 63 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 67 | 59 | 63 | 60 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 68 | 66 | 64 | 61 | 64 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 67 | 71 | 62 | 65 | 66 | 68 | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 65 | 70 | 67 | 73 | 67 | 66 | 70 | | | | | | | | | | | | | | | | | | | | | | |
| 9 | 65 | 62 | 64 | 70 | 70 | 63 | 68 | 69 | | | | | | | | | | | | | | | | | | | | | |
| 10 | 67 | 70 | 69 | 63 | 62 | 72 | 73 | 70 | 65 | | | | | | | | | | | | | | | | | | | | |
| 11 | 56 | 63 | 65 | 69 | 61 | 58 | 58 | 66 | 60 | 65 | | | | | | | | | | | | | | | | | | | |
| 12 | 51 | 44 | 56 | 54 | 51 | 50 | 52 | 53 | 48 | 56 | 57 | | | | | | | | | | | | | | | | | | |
| 13 | 65 | 67 | 62 | 63 | 64 | 69 | 66 | 66 | 63 | 67 | 62 | 47 | | | | | | | | | | | | | | | | | |
| 14 | 58 | 58 | 55 | 66 | 65 | 57 | 62 | 63 | 65 | 59 | 67 | 46 | 58 | | | | | | | | | | | | | | | | |
| 15 | 52 | 60 | 53 | 58 | 52 | 59 | 58 | 54 | 57 | 64 | 63 | 48 | 56 | 56 | | | | | | | | | | | | | | | |
| 16 | 69 | 61 | 63 | 57 | 64 | 57 | 65 | 60 | 58 | 63 | 62 | 54 | 62 | 59 | 52 | | | | | | | | | | | | | | |
| 17 | 63 | 64 | 61 | 64 | 70 | 61 | 65 | 62 | 66 | 68 | 71 | 58 | 60 | 66 | 59 | 67 | | | | | | | | | | | | | |
| 18 | 69 | 71 | 65 | 65 | 68 | 68 | 73 | 70 | 66 | 68 | 58 | 50 | 71 | 62 | 54 | 58 | 66 | | | | | | | | | | | | |
| 19 | 74 | 71 | 66 | 67 | 66 | 70 | 69 | 67 | 69 | 69 | 60 | 53 | 68 | 60 | 57 | 66 | 69 | 71 | | | | | | | | | | | |
| 20 | 61 | 60 | 62 | 61 | 68 | 62 | 64 | 64 | 66 | 65 | 66 | 56 | 62 | 62 | 67 | 62 | 67 | 66 | 66 | | | | | | | | | | |
| 21 | 63 | 63 | 64 | 64 | 66 | 63 | 66 | 64 | 64 | 68 | 64 | 54 | 56 | 64 | 56 | 66 | 71 | 61 | 65 | 62 | | | | | | | | | |
| 22 | 64 | 64 | 62 | 64 | 66 | 64 | 69 | 67 | 62 | 65 | 59 | 50 | 62 | 65 | 51 | 70 | 68 | 62 | 63 | 58 | 72 | | | | | | | | |
| 23 | 65 | 57 | 57 | 56 | 55 | 58 | 62 | 65 | 55 | 66 | 57 | 44 | 58 | 59 | 49 | 60 | 60 | 62 | 64 | 52 | 64 | 64 | | | | | | | |
| 24 | 63 | 56 | 58 | 62 | 59 | 59 | 68 | 66 | 65 | 66 | 60 | 50 | 67 | 59 | 49 | 58 | 58 | 58 | 62 | 61 | 60 | 62 | 60 | | | | | | |
| 25 | 47 | 49 | 42 | 51 | 46 | 39 | 49 | 48 | 46 | 49 | 40 | 39 | 48 | 48 | 44 | 46 | 53 | 53 | 47 | 44 | 49 | 52 | 42 | 48 | | | | | |
| 26 | 68 | 70 | 70 | 68 | 68 | 66 | 72 | 72 | 66 | 71 | 64 | 50 | 69 | 58 | 57 | 61 | 67 | 72 | 74 | 65 | 65 | 65 | 64 | 71 | 51 | | | | |
| 27 | 62 | 59 | 58 | 55 | 55 | 59 | 61 | 62 | 59 | 62 | 56 | 45 | 60 | 56 | 50 | 58 | 52 | 64 | 63 | 58 | 54 | 57 | 56 | 65 | 40 | 66 | | | |
| 28 | 75 | 64 | 64 | 66 | 64 | 68 | 72 | 66 | 66 | 70 | 57 | 49 | 68 | 60 | 54 | 64 | 62 | 69 | 73 | 61 | 66 | 60 | 62 | 64 | 41 | 66 | 64 | | |
| 29 | 69 | 70 | 69 | 60 | 71 | 69 | 71 | 65 | 64 | 66 | 61 | 50 | 62 | 60 | 54 | 66 | 67 | 70 | 72 | 63 | 66 | 66 | 60 | 64 | 46 | 72 | 57 | 69 | |
| 30 | 62 | 66 | 61 | 64 | 59 | 64 | 68 | 64 | 60 | 66 | 59 | 46 | 59 | 56 | 59 | 55 | 63 | 64 | 64 | 62 | 60 | 61 | 58 | 57 | 43 | 65 | 57 | 59 | 63 |

[a]Decimals have been omitted.

Table 7. Intercorrelations of Language Arts Concepts: Girls[a]

| Concept | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 71 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 66 | 67 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 69 | 66 | 70 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 70 | 69 | 70 | 64 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 70 | 70 | 71 | 66 | 68 | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 74 | 71 | 67 | 64 | 70 | 71 | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 65 | 65 | 66 | 64 | 64 | 68 | 62 | | | | | | | | | | | | | | | | | | | | | | |
| 9 | 59 | 62 | 62 | 66 | 60 | 64 | 62 | 61 | | | | | | | | | | | | | | | | | | | | | |
| 10 | 71 | 69 | 70 | 68 | 70 | 71 | 73 | 68 | 68 | | | | | | | | | | | | | | | | | | | | |
| 11 | 53 | 52 | 55 | 52 | 52 | 52 | 51 | 60 | 54 | 57 | | | | | | | | | | | | | | | | | | | |
| 12 | 54 | 56 | 50 | 56 | 52 | 54 | 52 | 54 | 51 | 48 | 45 | | | | | | | | | | | | | | | | | | |
| 13 | 76 | 67 | 62 | 67 | 69 | 70 | 70 | 63 | 60 | 70 | 51 | 55 | | | | | | | | | | | | | | | | | |
| 14 | 60 | 66 | 62 | 68 | 59 | 60 | 60 | 67 | 60 | 62 | 56 | 56 | 58 | | | | | | | | | | | | | | | | |
| 15 | 57 | 58 | 55 | 51 | 54 | 55 | 58 | 56 | 55 | 56 | 62 | 54 | 52 | 55 | | | | | | | | | | | | | | | |
| 16 | 68 | 66 | 61 | 60 | 61 | 64 | 68 | 60 | 61 | 68 | 57 | 53 | 63 | 51 | 55 | | | | | | | | | | | | | | |
| 17 | 64 | 61 | 61 | 59 | 63 | 64 | 64 | 63 | 67 | 68 | 64 | 52 | 63 | 62 | 59 | 67 | | | | | | | | | | | | | |
| 18 | 72 | 70 | 66 | 62 | 67 | 68 | 71 | 63 | 61 | 66 | 50 | 54 | 68 | 56 | 51 | 62 | 59 | | | | | | | | | | | | |
| 19 | 73 | 72 | 69 | 69 | 68 | 71 | 77 | 61 | 65 | 71 | 53 | 58 | 72 | 59 | 56 | 66 | 61 | 71 | | | | | | | | | | | |
| 20 | 60 | 62 | 59 | 57 | 58 | 66 | 57 | 61 | 54 | 63 | 68 | 54 | 58 | 59 | 62 | 62 | 65 | 61 | 58 | | | | | | | | | | |
| 21 | 64 | 62 | 64 | 60 | 63 | 63 | 64 | 61 | 57 | 67 | 58 | 63 | 63 | 62 | 57 | 62 | 65 | 62 | 64 | 56 | | | | | | | | | |
| 22 | 68 | 67 | 68 | 66 | 67 | 66 | 68 | 66 | 64 | 69 | 60 | 49 | 68 | 64 | 60 | 70 | 63 | 71 | 70 | 58 | 71 | | | | | | | | |
| 23 | 66 | 60 | 62 | 60 | 60 | 66 | 65 | 59 | 62 | 66 | 58 | 47 | 59 | 57 | 54 | 68 | 63 | 58 | 65 | 56 | 66 | 70 | | | | | | | |
| 24 | 63 | 64 | 64 | 61 | 59 | 60 | 62 | 63 | 58 | 63 | 52 | 52 | 59 | 60 | 51 | 59 | 54 | 67 | 64 | 51 | 57 | 64 | 53 | | | | | | |
| 25 | 47 | 49 | 48 | 53 | 43 | 49 | 49 | 48 | 52 | 50 | 50 | 39 | 50 | 52 | 46 | 45 | 47 | 44 | 48 | 51 | 47 | 54 | 46 | 45 | | | | | |
| 26 | 73 | 66 | 72 | 66 | 67 | 72 | 71 | 65 | 67 | 72 | 54 | 52 | 67 | 54 | 56 | 62 | 61 | 68 | 71 | 60 | 65 | 70 | 65 | 59 | 50 | | | | |
| 27 | 57 | 55 | 55 | 49 | 57 | 55 | 57 | 49 | 51 | 61 | 40 | 35 | 56 | 49 | 42 | 53 | 49 | 58 | 56 | 46 | 52 | 55 | 50 | 52 | 43 | 60 | | | |
| 28 | 71 | 66 | 64 | 60 | 65 | 67 | 74 | 60 | 65 | 66 | 54 | 47 | 66 | 54 | 54 | 65 | 63 | 74 | 70 | 57 | 62 | 70 | 62 | 64 | 43 | 66 | 58 | | |
| 29 | 69 | 69 | 64 | 59 | 65 | 68 | 73 | 59 | 61 | 65 | 50 | 50 | 66 | 54 | 52 | 62 | 61 | 61 | 69 | 51 | 63 | 60 | 62 | 52 | 48 | 65 | 54 | 63 | |
| 30 | 66 | 61 | 61 | 70 | 66 | 62 | 63 | 58 | 58 | 68 | 56 | 52 | 64 | 64 | 53 | 64 | 66 | 61 | 66 | 63 | 63 | 69 | 60 | 53 | 51 | 63 | 49 | 58 | 60 |

[a]Decimals have been omitted.

Table 8. Intercorrelations of Language Arts Tasks: Boys[a]

| Task | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 89 | | | | | | | | | | |
| 3 | 90 | 86 | | | | | | | | | |
| 4 | 84 | 82 | 82 | | | | | | | | |
| 5 | 85 | 85 | 86 | 83 | | | | | | | |
| 6 | 83 | 87 | 86 | 82 | 85 | | | | | | |
| 7 | 77 | 79 | 74 | 75 | 78 | 82 | | | | | |
| 8 | 86 | 88 | 86 | 83 | 86 | 90 | 81 | | | | |
| 9 | 83 | 83 | 82 | 82 | 85 | 86 | 81 | 86 | | | |
| 10 | 84 | 84 | 83 | 82 | 86 | 85 | 80 | 87 | 82 | | |
| 11 | 75 | 78 | 78 | 77 | 81 | 80 | 75 | 83 | 78 | 79 | |
| 12 | 72 | 76 | 73 | 72 | 75 | 81 | 79 | 80 | 81 | 76 | 75 |

[a]Decimals have been omitted.

Table 9. Intercorrelations of Language Arts Tasks: Girls[a]

| Task | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 88 | | | | | | | | | | |
| 3 | 88 | 85 | | | | | | | | | |
| 4 | 83 | 80 | 84 | | | | | | | | |
| 5 | 83 | 85 | 84 | 79 | | | | | | | |
| 6 | 86 | 86 | 83 | 78 | 82 | | | | | | |
| 7 | 78 | 80 | 76 | 73 | 80 | 81 | | | | | |
| 8 | 86 | 88 | 85 | 81 | 87 | 86 | 81 | | | | |
| 9 | 86 | 88 | 84 | 80 | 84 | 87 | 80 | 90 | | | |
| 10 | 84 | 85 | 84 | 80 | 83 | 84 | 80 | 87 | 88 | | |
| 11 | 76 | 77 | 76 | 77 | 78 | 77 | 74 | 81 | 80 | 77 | |
| 12 | 79 | 82 | 79 | 78 | 81 | 81 | 82 | 86 | 85 | 85 | 77 |

[a]Decimals have been omitted.

Table 10. Numbers of Initial and Derived Factors for Concept Scores: Boys and Girls

| Factor Method | Initial Factors | | Derived Orthogonal Factors: Common | | Specific | | Null | | Derived Oblique Factors: Common | | Specific | | Null | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G | B | G | B | G |
| Alpha | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| Harris R-$S^2$ | 17 | 17 | 7 | 8 | 2 | 1 | 8 | 8 | 6 | 6 | 2 | 2 | 0 | 0 |
| UMLFA | 3 | 4 | 3 | 4 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 0 | 0 |

Table 11. Numbers of Initial and Derived Factors for Task Scores: Boys and Girls

| Factor Method | Initial Factors | | Derived Orthogonal Factors | | | | | | Derived Oblique Factors | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Common | | Specific | | Null | | Common | | Specific | | Null | |
| | B | G | B | G | B | G | B | G | B | G | B | G | B | G |
| Alpha | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Harris R-$S^2$ | 5 | 6 | 3 | 3 | 0 | 0 | 2 | 3 | 3 | 3 | 0 | 0 | 0 | 0 |
| UMLFA | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 1 | 0 | 0 |

.80s for both boys and girls with three for boys and two for girls in the .70s—Tasks 7, 11, and 12 for boys and Tasks 7 and 11 for girls. Thus, as with the concepts, if the correlations were corrected for attenuation they would be extremely high. The uncorrected correlations are all quite high.

## Conventional Factor Analyses

The number of factors obtained for the initial solutions and for the derived solutions, orthogonal and oblique, are given in Tables 10 and 11, according to the numbers of common, specific, and null factors. A common factor is defined as one having at least two variables with coefficients greater than .30 (absolute); a specific factor has only one coefficient greater than .30 (absolute); and a null factor does not have any coefficients greater than .30 (absolute). The factors rotated for the derived oblique solutions were the orthogonal common factors obtained for that method. For this purpose a common factor was defined as one having at least two variables with coefficients greater than .300 (absolute).

The derived orthogonal common factor results can be found in Appendices A-D; the derived oblique common factor results are presented in Tables 12-15. Only coefficients greater than .30 (absolute) are included. The order of the factors for each solution is arbitrary. The intercorrelations of the factors are included in the tables for the oblique solutions.

*Interpretation of factor results for concept scores.* The factor results for the concepts can be interpreted at two levels. One level is a general one. The most reasonable interpretation is that all 30 of the concepts are measures of a single functional relationship existing among the concepts; this holds for both boys and girls. At least four things lead to such an interpretation. First, the intercorrelations of the 30 concepts are all quite uniform. They would probably fit a Spearman pattern fairly well; this indicates a single common factor. The correlations, if corrected for attenuation, would all be quite high. The eigenvalues of the correlation matrices obtained for both boys and girls are characterized by the first one being very large followed by a great drop in magnitude to the next ones which diminish very gradually. Finally, the oblique factor intercorrelations are uniformly extremely high, indicating only one second order factor. Such an interpretation is reasonable in terms of past studies, also. In the literature for factor studies that include measures of achievement, the results typically indicate that achievement measures are found on a single factor. We have here achievement measures for a single subject matter field which, conceptually at least, should be even more closely related than achievement measures from several different areas of study.

The other level at which the factor results can be interpreted is a more specific one. The derived orthogonal factors are not very meaningful; they are not very interpretable psychologically. As can be seen from Tables 12 and 13, the oblique factors are very highly correlated; thus, imposing the restriction of orthogonality on the factors for these sets of data gives results that are not very meaningful. Many of the variables are of complexity 2, 3, and even higher in the orthogonal solutions. For example, for the two factors of the Alpha solution for the girls, all but one of the concepts have coefficients greater than .30 on both of the factors; for the UMLFA solutions, most of the variables are of complexity 3 for the three factors obtained for boys and for the four factors obtained for girls. Even for the greater number of factors for the Harris R-$S^2$ solutions, there are still a large number of concept variables of complexity 2, 3, and 4. Thus, at a more specific level, the only solutions which it makes any sense to interpret

Table 12. Oblique Common Factor Results for Language Arts Concepts: Boys[a]

| Concept | Alpha | Harris R-S[2] | | | | | | UMLFA | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A-1 | H-1 | H-2 | H-3 | H-4 | H-5 | H-6 | U-1 | U-2 | U-3 |
| Area: Words | | | | | | | | | | |
| 1 Abbreviation | 81 | 83 | | | | | | 81 | -39 | 39 |
| 2 Compound Word | 81 | 84 | | | | | | 84 | | |
| 3 Consonant | 79 | 44 | | | | | | 54 | | |
| 4 Contraction | 80 | | | | | | 98 | 46 | 48 | |
| 5 Homonym | 80 | | | | 100 | | | | | 56 |
| 6 Short Vowel | 80 | 83 | | | | | | 90 | | |
| 7 Silent Letter | 84 | 53 | | | | | | 86 | | |
| 8 Suffix | 83 | | | | | | 59 | 74 | | |
| 9 Synonym | 80 | | | | 61 | | 44 | 52 | | |
| 10 Word | 84 | 51 | 34 | | | | | 70 | | |
| Area: Words in Sentences | | | | | | | | | | |
| 11 Adjective | 78 | -50 | 51 | | | | 35 | | 98 | |
| 12 Helping Verb | 64 | | | | | | | | 43 | 33 |
| 13 Period | 80 | 45 | | | | 36 | | 96 | | |
| 14 Possessive Noun | 76 | -51 | | 46 | 37 | | 33 | | 45 | 40 |
| 15 Predicate | 70 | | 105 | | | | | | 72 | |
| 16 Present Tense | 77 | | | 80 | | | | | | 95 |
| 17 Pronoun | 82 | | | 37 | 39 | | | | 38 | 75 |
| 18 Question Mark | 83 | 60 | | -34 | | | | 104 | | |
| 19 Sentence | 84 | 84 | | | | | | 82 | | |
| 20 Verb | 79 | | 60 | | 48 | | | | 53 | |
| Area: Connected Discourse | | | | | | | | | | |
| 21 Comparison | 80 | | | 77 | | | | | | 86 |
| 22 Details | 80 | | | 90 | | | | | | 89 |
| 23 Explanation | 74 | | | 79 | -31 | 31 | | 44 | | 43 |
| 24 Greeting | 78 | | | | | 98 | | 80 | | |
| 25 Heading | 59 | | | | | | | | | |
| 26 Paragraph | 84 | 36 | | | | 41 | | 88 | | |
| 27 Return Address | 73 | | | | | 76 | | 91 | | |
| 28 Thank You Letter | 81 | 79 | | | | | | 93 | | |
| 29 Title | 82 | 66 | | | 40 | | | 61 | | 43 |
| 30 Topic Sentence | 77 | 42 | 42 | | | | | 64 | | |
| Intercorrelations of factors: 2 | | 88 | | | | | | 89 | | |
| 3 | | 91 | 87 | | | | | 93 | 89 | |
| 4 | | 90 | 88 | 91 | | | | | | |
| 5 | | 93 | 85 | 88 | 88 | | | | | |
| 6 | | 89 | 89 | 88 | 88 | 89 | | | | |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

Table 13. Oblique Common Factor Results for Language Arts Concepts: Girls[a]

| Concept | Alpha | | Harris R-S² | | | | | | UMLFA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A-1 | A-2 | H-1 | H-2 | H-3 | H-4 | H-5 | H-6 | U-1 | U-2 | U-3 | U-4 |
| Area: Words | | | | | | | | | | | | |
| 1 Abbreviation | 98 | | 56 | | | | | | 78 | | | |
| 2 Compound Word | 78 | | 40 | | | | | | 35 | | | 31 |
| 3 Consonant | 75 | | | | 88 | | | | | | 45 | |
| 4 Contraction | 58 | | | | 43 | | | 62 | | | 102 | |
| 5 Homonym | 89 | | 32 | | 40 | | | 36 | 62 | | | |
| 6 Short Vowel | 81 | | 64 | | 53 | | | | 64 | | | |
| 7 Silent Letter | 107 | | 81 | | | | | | 108 | | | |
| 8 Suffix | 39 | 42 | | | 87 | | | | | | 53 | |
| 9 Synonym | 50 | | | | | | | | 39 | | | |
| 10 Word | 78 | | 31 | | 33 | | | | 75 | | | |
| Area: Words in Sentences | | | | | | | | | | | | |
| 11 Adjective | -34 | 110 | -31 | 79 | | | | | | 103 | | |
| 12 Helping Verb | | 44 | | | | | | | | | 51 | |
| 13 Period | 90 | | 55 | | | | | 34 | 72 | | | |
| 14 Possessive Noun | | 61 | -38 | | 57 | | | | | | 96 | |
| 15 Predicate | | 78 | | 55 | | | | | | 63 | | |
| 16 Present Tense | 52 | | | | -31 | | 52 | | 69 | | | |
| 17 Pronoun | | 63 | | 54 | | | | | 60 | 54 | | |
| 18 Question Mark | 102 | | | | | 95 | | | | | | 97 |
| 19 Sentence | 100 | | 51 | | | | | | 76 | | | |
| 20 Verb | | 88 | | 83 | | | -32 | | | 67 | | |
| Area: Connected Discourse | | | | | | | | | | | | |
| 21 Comparison | 48 | 33 | | | | | 70 | | 57 | | | |
| 22 Details | 59 | | -34 | | | 47 | 67 | | | | | |
| 23 Explanation | 51 | | | | | | 89 | | 88 | | | |
| 24 Greeting | 66 | | -45 | | 32 | 101 | | | -44 | | | 89 |
| 25 Heading | | 52 | | | | | | | | | 48 | |
| 26 Paragraph | 83 | | 45 | | 52 | | | | 59 | | | |
| 27 Return Address | 86 | | 41 | | | 37 | | | 56 | | | |
| 28 Thank You Letter | 98 | | | | | 84 | | | 57 | | -52 | 65 |
| 29 Title | 89 | | 109 | | | -34 | | | 128 | | | |
| 30 Topic Sentence | 39 | 42 | | | | | | 102 | 54 | | 47 | |
| Intercorrelations of factors: 2 | 90 | | 81 | | | | | | 85 | | | |
| 3 | | | 92 | 85 | | | | | 93 | 87 | | |
| 4 | | | 94 | 82 | 92 | | | | 93 | 80 | 89 | |
| 5 | | | 90 | 88 | 90 | 90 | | | | | | |
| 6 | | | 91 | 84 | 92 | 90 | 91 | | | | | |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

Table 14. Oblique Common Factor Results for Language Arts Tasks: Boys[a]

| Task | Alpha | Harris R-S² | | | UMLFA | | |
|---|---|---|---|---|---|---|---|
| | A-1 | H-1 | H-2 | H-3 | U-1 | U-2 | U-3 |
| 1 Given name of attribute, select example. | 91 | 121 | | | 100 | | |
| 2 Given example of attribute, select name. | 93 | 89 | | | 31 | 52 | |
| 3 Given name of concept, select example. | 91 | 83 | 38 | | | 112 | -41 |
| 4 Given name of concept, select nonexample. | 89 | 40 | 52 | | | 77 | |
| 5 Given example of concept, select name. | 93 | | 94 | | | 111 | |
| 6 Given concept, select relevant attribute. | 94 | | | 49 | | 89 | |
| 7 Given concept, select irrelevant attribute. | 86 | | | 92 | | | 96 |
| 8 Given definition of concept, select name. | 95 | | 46 | | | 91 | |
| 9 Given name of concept, select definition. | 91 | | | 60 | | 42 | 43 |
| 10 Given concept, select supraordinate concept. | 92 | | 91 | | | 78 | |
| 11 Given concept, select subordinate concept. | 86 | -35 | 116 | | | 101 | |
| 12 Given two concepts, select relationship. | 84 | | | 105 | | | 85 |
| Intercorrelations of factors: 2 | | 97 | | | 92 | | |
| 3 | | 93 | 97 | | 83 | 94 | |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

Table 15. Oblique Common Factor Results for Language Arts Tasks: Girls[a]

| Task | Alpha | Harris R-S² | | | UMLFA | |
|---|---|---|---|---|---|---|
| | A-1 | H-1 | H-2 | H-3 | U-1 | U-2 |
| 1 Given name of attribute, select example. | 92 | 111 | | -35 | 117 | |
| 2 Given example of attribute, select name. | 93 | 88 | | | 66 | 39 |
| 3 Given name of concept, select example. | 91 | 76 | 48 | -31 | 74 | |
| 4 Given name of concept, select nonexample. | 88 | | 90 | | | |
| 5 Given example of concept, select name. | 91 | | | 42 | | 61 |
| 6 Given concept, select relevant attribute. | 92 | 87 | | 31 | 59 | 47 |
| 7 Given concept, select irrelevant attribute. | 86 | | | 98 | | 100 |
| 8 Given definition of concept, select name. | 94 | | | 61 | | 83 |
| 9 Given name of concept, select definition. | 94 | 52 | | 58 | | 80 |
| 10 Given concept, select supraordinate concept. | 92 | 33 | | 56 | | 75 |
| 11 Given concept, select subordinate concept. | 85 | -44 | 61 | 69 | | 79 |
| 12 Given two concepts, select relationship. | 90 | | | 111 | -46 | 129 |
| Intercorrelations of factors: 2 | | 97 | | | 96 | |
| 3 | | 97 | 96 | | | |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

are the oblique ones. It must be remembered, however, that the correlations of these factors are all extremely high.

For matrices which yield about the same number of factors when different methods are used, Harris and Harris (1970) suggest taking the comparable common factors, those that are robust over method, as the substantive results. This idea does not seem to be appropriate when the number of common factors obtained using different methods varies considerably, as is the case with the factoring of these language arts concepts: for boys and girls respectively, 1 and 2 for Alpha, 6 each for Harris R-$S^2$, and 3 and 4 for UMLFA. Thus it seems the only appropriate thing is to look at the results for each method individually.

The results for the boys are given in Table 12. For these language arts concepts, Alpha yielded just one common factor. The coefficients on this factor are all quite uniform for the 30 concepts.

The UMLFA method yielded three common factors. U-1 is a quite general factor including many of the concepts from Areas 1 and 3, Words and Connected Discourse. Only three of the concepts from Area 2, Words in Sentences, appear on U-1, however. These three are probably the more familiar concepts from this area. U-2 seems to be a factor for the parts of speech. All of the six studied appear on this factor. U-3 is curious and difficult to explain. The main concepts on the factor are Present Tense, Pronoun, Details, Comparison, and Homonym. It cuts across all three areas and perhaps these are the less familiar concepts in each of the areas.

The Harris R-$S^2$ solution is, in general, much more difficult to interpret than the others. Even with the greater number of factors and the relatively few variables on each of the factors, the factors are still extremely highly correlated. Adding to the difficulty of the interpretation is the fact that 12 of the concept variables are of complexity 2, 3, or 4. Of these 12, four are bipolar. All of these things seem to add credence to the interpretation of a single functional relationship existing among the 30 concepts studied. H-1 is rather general including some concepts from each of the three areas. Perhaps these are the more familiar concepts from each of the three areas. Three of the six parts of speech studied—Predicate, Verb, and Adjective—appear on H-2. The main variables appearing on H-3 are Details, Present Tense, Explanation, and Comparison. A possible interpretation is some kind of "happening now" type of relationship. H-4 is essentially a doublet for Homonym and Synonym. All of the other concepts appearing on H-4 have larger coefficients on other factors, except Pronoun whose coefficient on H-4 is quite small, and it has another coefficient almost as large. H-5 is essentially a doublet for Greeting and Return Address. These are two parts of a letter that appear before the body of the letter, but Heading does not appear on this factor. A more general interpretation is simply parts of a letter since these three concepts were the only three parts of a letter studied. H-6 is essentially a doublet for Contraction and Suffix. In a very general sense both of these concepts have to do with the ending of a word.

The results for the girls interpreted here are given in Table 13. The Alpha results are the easiest to interpret. Alpha yielded two factors for girls as contrasted with only one for boys. A-1 is a very general factor including all of the concepts from Area 1, all except Heading from Area 3, and four of the Area 2 concepts—Period, Question Mark, Sentence, and Present Tense. Perhaps these are the more familiar concepts from Area 2; another interpretation is that they are all of the concepts that are not parts of speech. The six concepts that are parts of speech appear on A-2 and are the main variables on that factor.

The UMLFA method yielded four factors for girls as compared to three for boys. Even though UMLFA yielded four factors for girls, it gives somewhat the same results as Alpha. U-1 is quite general including many of the concepts from Areas 1 and 3 and the same four concepts from Area 2 that are on A-1. Four of the six parts of speech appear on U-2; these are the four "nonqualified" ones (Adjective, Predicate, Pronoun, and Verb). The other two parts of speech—the qualified ones (Possessive Noun and Helping Verb)—appear on U-3 with Contraction, Suffix, Consonant, and Heading. There is no readily apparent rationale for this; perhaps these are less familiar concepts. U-4 is essentially a doublet for Question Mark and Greeting, with Thank You Letter and Compound Word appearing to some extent. This is unexplainable.

As with the boys, Harris R-$S^2$ results are much more difficult to interpret than the others. For the girls, 14 of the 30 concept variables are of complexity 2 or 3; seven of these are bipolar. H-1 is the most general of the Harris R-$S^2$ factors. It includes some concepts from all three areas. It is less inclusive than the general factors from the other two methods, A-1 and U-1. These are perhaps the more familiar concepts; the main ones are Title, Silent Letter, Short Vowel, Abbreviation, Period,

and Sentence. H-2 is the same as U-2; it includes the four "nonqualified" parts of speech. For both UMLFA and Harris R-S[2] this factor is the least correlated with the remaining factors of any of the factors obtained. H-3 includes six of the Words Area concepts along with Possessive Noun and Paragraph. There is no apparent rationale for this. H-4 is similar to U-4 with the main variables appearing on it being Question Mark, Greeting, and Thank You Letter. Explanation, Comparison, Details, and Present Tense are the variables appearing on H-5. This is the "happening now" relationship of the boys' H-3 and a major part of U-3. H-6 is essentially a specific for Topic Sentence or a doublet for Topic Sentence and Contraction.

It is evident from the factor results that the three area distinctions are not functional distinctions; thus, the hypothesis that language arts concepts are functionally related according to the three conceptually determined major content areas must be rejected.

A word of caution. Too much emphasis should not be placed on the distinctions just discussed, as the intercorrelations of the factors are extremely high. The two factors of the Alpha solution for girls are correlated .90. There are only four concepts that are of complexity 2; one of these is bipolar. As one would expect, as the results become more specific (more factors) some of the factors are less correlated. However, for the six factors of the Harris R-S[2] solutions, the correlations are in the .80s and .90s for both boys and girls; these correlations are very high, especially considering that there are relatively few variables on many of the factors.

It may be well to insert a reminder here that the orthogonal solutions are not very meaningful psychologically since the complexity is greater than 1 for most of the concepts; most of the concepts appear on more than one factor.

The most interesting aspect of studying these language arts concepts is yet to come: the study of the relationships of selected language arts concepts with selected concepts from the other three subject matter fields being studied (mathematics, science, and social studies). This is Step 4 of the objectives of the CAA Project as stated on page 1.

*Interpretation of factor results for task scores.* As with the concepts, the factor results for the tasks can be interpreted at two levels. One level is a general one; all 12 of the tasks are measures of a single underlying ability or latent trait. This seems to be the most reasonable interpretation for the tasks since the intercorrelations of the oblique factors are extremely high when more than one factor is yielded. All of the reasons for a general interpretation for the concepts apply for the interpretation of the tasks: (a) the intercorrelations are all extremely high and quite uniform—they would fit a Spearman pattern fairly well, (b) the correlations corrected for attentuation would all be extremely high, (c) the eigenvalues of the correlation matrices are characterized by the first one being very large followed by a great drop in magnitude to the next ones, and (d) the factor intercorrelations are uniformly very high, indicating only one second order factor.

At a more specific level, only the oblique factor results are psychologically meaningful. These results are given in Table 14 for boys and Table 15 for girls.

For the boys, Alpha yielded only one common factor. Both UMLFA and Harris R-S[2] yielded three factors but they are all highly correlated; the three factors of the two different solutions are quite similar but there are some striking differences. H-1 is more inclusive than U-1 including Tasks 1, 2, and 3 while U-1 is, in essence, a specific for Task 1. There is no apparent explanation for Tasks 1, 2, and 3 appearing together. They all have to do with examples of a concept but so do Tasks 4 and 5. Tasks 1 and 2 deal with examples of an attribute of the selected concept which is, in itself, a concept. Tasks 3, 4, and 5 deal with examples of the selected concept. U-2 is more inclusive than H-2 including 9 of the 12 tasks. U-2 includes at least one variable for each of five of the six ability hypotheses and H-2 includes variables representing four of these six hypothesized abilities. H-3 and U-3 are essentially the same with the variables appearing being Tasks 7, 9, and 12. Task 6 also appears on H-3 but with a somewhat smaller coefficient. Tasks 7 and 12 have the largest coefficients. Both of these tasks go beyond the characteristics of the concept itself and involve relationships with other concepts. Task 12 does this directly; Task 7 requires that the student distinguish between attributes that are necessary for an exemplar to be identified as an exemplar of that particular concept (relevant attributes) and those that are an attribute of the concept but are not necessary to identify it as an exemplar of that particular concept (irrelevant attributes). For example, a relevant attribute of both Period and Question Mark is "punctuation mark that appears at the end of a sentence." The relevant attribute that distinguishes these two concepts from each other is the type of sen-



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tence—a period appears at the end of a statement and a question mark at the end of a question. The location at the end of a sentence is an irrelevant attribute; it is an attribute of the two concepts but it does not help to distinguish between the two. Irrelevant attributes often identify concepts that are conceptually subordinate to a given concept. In this sense Task 7 involves relationships with other concepts. Task 6 is essentially the reverse of Task 7, however. It requires selecting a relevant attribute from irrelevant ones, while Task 7 requires selecting an irrelevant attribute from relevant ones.

Alpha yielded just one factor for the girls also, while UMLFA yielded two and Harris R-$S^2$ three. The UMLFA factors are correlated .96 and the Harris R-$S^2$ factors are correlated .97, .97, and .96. With factor correlations this high it is senseless to try to make any distinctions among the factors. Attempting to interpret them upholds this view; it is impossible. An interesting thing to point out, however, is that Task 4 is essentially a specific for Harris R-$S^2$ (H-2) and was the variable on a specific factor in the UMLFA solution. For Harris R-$S^2$ it is correlated .97 and .96 with H-1 and H-3 respectively. It is correlated .91 and .92 with U-1 and U-2 respectively.

It must be remembered that the correlations of these task factors, when more than one is yielded, are in the mid to high .90s with the exception of U-1 and U-3 for boys, which is .83. Thus, not much if any emphasis should be placed on the distinctions just discussed. The most defensible interpretation is that there is a single common factor for these 12 tasks.

As with the concepts, the most interesting aspect of studying these tasks using language arts content will be to see the relationship to these same tasks when mathematics, science, and social studies concepts are employed as content.

## Three-Mode Factor Analyses

As was discussed earlier, a three-mode factor analysis was performed on two different forms of the same data to gain insight into the existence of any important concept-task interactions for the idealized persons. Performing conventional factor analyses on the two modes, concepts and tasks, separately is essentially hypothesizing that there are no interactions. The three-mode analyses were performed to determine whether this hypothesis is a tenable one.

The Type I three-mode analysis is the analysis of the 12 tasks and the three composite concept variables; Type II is the analysis of the three composite task variables and the 30 concepts. Type I was performed to permit maximum task interactions to be evident; Type II to permit maximum concept interactions.

The core matrix obtained for each analysis is the only piece of the three-mode analysis of interest here since it contains the idealized person components by task components by concept components. Hence, it is in this matrix that any interactions are seen. The core matrices obtained for Type I and Type II analyses are presented in Table 16 for boys and in Table 17 for girls. Only those idealized person (core) components that have one or more coefficients greater than .50 (absolute) are included in the tables; the number of core components obtained in each of the analyses was equal to the product of the number of components for the two modes other than individuals. The variables comprising the task components are given in footnotes on each of the tables. Note that the task components obtained for the Type I analysis for both boys and girls are quite different from the tasks composing each of the composite task variables input into the Type II analysis; the ones obtained for the Type I analysis are identical for boys and girls. The concept components for the Type II analyses bear little resemblance to the Harris R-$S^2$ factors which were the basis for the number of components to be extracted; the concept components obtained are much more specific. Most of them have only two or three variables with coefficients greater than .30 (absolute) and three of them for the boys have only one coefficient greater than .30. These differences are not surprising or critical since the oblique factors are extremely highly correlated.

Both Type I and Type II analyses for the boys indicate that there is only one idealized person type—there is just one major core component. As indicated by the Type I analysis, persons respond similarly to the concepts of the three different areas; the Type II analysis indicates some slight differentiation among the concepts. For the Type I analysis, a person who scores well on core component 1 tends to do less well on Tasks 7, 11, and 12 (task components 2 and 3). A person who has low scores on core component 1 would tend to perform better on Tasks 7, 11, and 12 than on the remaining ones. In the Type I analysis there are no other coefficients greater than .75 (absolute). Of the total of 18 core components obtained for the Type II analysis, there are

Table 16. Three-Mode Core Results: Boys

Type I

| Idealized Persons | Task Components[a] | Concept Components: Area 1 | Area 2 | Area 3 |
|---|---|---|---|---|
| 1 | 1 | 2.46 | 2.40 | 2.38 |
| | 2 | .80 | .74 | .66 |
| | 3 | 1.07 | .89 | 1.07 |
| 2 | 1 | -.38 | .13 | -.31 |
| | 2 | -.01 | .14 | .12 |
| | 3 | .23 | .68 | .32 |

Type II

| Idealized Persons | Task Components[a] | Concept Components: 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 1.18 | .48 | 1.36 | 1.45 | .65 | 2.25 |
| | 2 | 1.14 | .49 | 1.41 | 1.70 | .41 | 2.51 |
| | 3 | 1.17 | .17 | 1.27 | 1.46 | .56 | 2.29 |
| 2 | 1 | -.35 | -.07 | -.14 | .24 | .09 | .97 |
| | 2 | -.18 | -.31 | -.26 | -.14 | -.32 | -.33 |
| | 3 | -.03 | -.20 | -.55 | -.40 | -.11 | -.15 |
| 3 | 1 | .17 | .36 | .14 | .21 | -.37 | .02 |
| | 2 | -.08 | .34 | -.20 | .19 | -.09 | -.13 |
| | 3 | -.08 | -.28 | -.33 | .53 | -.29 | -.06 |
| 4 | 1 | .20 | .17 | .52 | .32 | .57 | -.12 |
| | 2 | .04 | -.23 | -.41 | .01 | .18 | .04 |
| | 3 | .02 | .11 | .02 | .10 | .27 | .04 |
| 5 | 1 | .01 | .22 | .05 | .15 | .18 | .01 |
| | 2 | -.02 | .11 | .28 | .12 | .30 | .09 |
| | 3 | -.18 | -.17 | -.09 | .18 | .03 | -.59 |
| 6 | 1 | .08 | .03 | .11 | .07 | -.07 | .09 |
| | 2 | .06 | .26 | .03 | -.26 | -.07 | .10 |
| | 3 | -.20 | .58 | -.13 | .09 | .05 | -.03 |

[a]Variables comprising task components:

Type I: 1 - Tasks 1-6, 8-10
2 - Task 11
3 - Tasks 7, 12

Type II: 1 - Tasks 1, 2, 3
2 - Tasks 4, 5, 8, 10, 11
3 - Tasks 6, 7, 9, 12

Table 17. Three-Mode Core Results: Girls

Type I

| Idealized Persons | Task Components[a] | Concept Components Area 1 | Area 2 | Area 3 |
|---|---|---|---|---|
| 1 | 1 | 2.51 | 2.40 | 2.42 |
| | 2 | .74 | .77 | .65 |
| | 3 | 1.09 | 1.05 | .98 |
| 2 | 1 | -.32 | .24 | -.32 |
| | 2 | -.16 | .14 | .51 |
| | 3 | .09 | .35 | .23 |

Type II

| Idealized Persons | Task Components[a] | Concept Components 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 2.15 | 1.52 | .11 | .85 | .87 | 1.58 |
| | 2 | -1.00 | -.82 | .23 | -.43 | -.48 | -.63 |
| | 3 | 1.85 | 1.78 | .15 | .78 | 1.19 | 1.23 |
| 2 | 1 | .56 | .55 | .54 | .38 | .28 | .03 |
| | 2 | 1.94 | 2.57 | .33 | .83 | .99 | 1.37 |
| | 3 | 1.14 | -.52 | .57 | .63 | .15 | .82 |
| 3 | 1 | .22 | 1.24 | .54 | .36 | .21 | .34 |
| | 2 | -1.36 | .79 | .28 | -.24 | -.85 | -.83 |
| | 3 | -.02 | -2.11 | .55 | .41 | -.37 | -.26 |
| 4 | 1 | -.14 | 1.36 | -.07 | -.12 | -.35 | -.40 |
| | 2 | .30 | -.21 | .14 | .12 | .14 | .13 |
| | 3 | -.30 | .37 | -.25 | -.15 | -.10 | -.23 |
| 5 | 1 | .31 | .06 | -.44 | -.10 | .19 | .12 |
| | 2 | .09 | .22 | -.38 | .17 | .10 | -.27 |
| | 3 | -.06 | -.17 | -.57 | -.07 | .13 | -.25 |
| 6 | 1 | .02 | -.06 | .02 | .15 | -.23 | -.27 |
| | 2 | -.10 | .11 | -.55 | .17 | .04 | -.25 |
| | 3 | .21 | .15 | .09 | .11 | -.17 | .02 |

[a]Variables comprising task components:

Type I: 1 - Tasks 1-6, 8-10
2 - Task 11
3 - Tasks 7, 12

Type II: 1 - Tasks 1, 2, 3, 6
2 - Task 4
3 - Tasks 5, 7-12

only six that have any coefficients greater than .50 (absolute) and, except for core component 1, there is only one coefficient greater than .75 (absolute). Core component 1 shows that the person who has high scores on this component does less well on concept component 2 which is essentially a specific for the concept Helping Verb, and on concept component 5 which is a specific for the concept Heading. (These two concepts did not appear on any of the Harris R-S$^2$ common factors.) A person with low scores on core component 1 would score better on these two concepts than on the remaining ones. As indicated by the one other coefficient that is greater than .75 (absolute), idealized person type 2 does well on concept component 6 (essentially the concept Return Address) for task component 1 (Tasks 1, 2, and 3). Other minor variations in response patterns for the idealized persons can be seen in Table 15.

As with the boys, the Type I three-mode analysis for girls yields just one major core component indicating just one idealized person type. Also like the boys, this analysis indicates that girls respond similarly to the concepts of the three different areas, doing less well on Tasks 7, 11, and 12. The Type II analysis for girls is quite different than it is for boys. Of the total of 18 idealized person (core) components, four of the six that have coefficients greater than .50 (absolute) have coefficients greater than .75 (absolute). There are more concept-task interactions but a closer look reveals that a lot of these are associated with task component 2 which is a specific for Task 4 (Given the name of a concept, select a nonexample of the concept). For idealized person type 1 (core component 1), a person who scores well on this core component does poorly on task component 2 (Task 4) for all concept components except number 3; this person does about average on concept component 3 for all of the task components. This seems strange at first and it seems to be an important task interaction—some persons respond differently to Task 4 than they do to the remaining tasks. Examination of all of the Task 4 items reveals a probable explanation for this interaction, however. For Task 4 items, the subject is required to select the nonexample of a given concept from possible choices which include examples and nonexamples. For multiple-choice test construction there can be, of course, only one nonexample given so there is only one correct answer. If more than one example is given as a possible choice (incorrect), the task can become one of selecting the one choice that is different from the others. Thus, Task 4 should be only a two-choice item so that the subject must know which is the example and which is the nonexample in order to answer the item correctly. When Task 4 items have more than two choices, the subject can answer the item correctly for one of two reasons—either she knows which of the choices is the nonexample or she can determine which one of the three or more choices is "different" from the remaining ones. The Task 4 items for the language arts concepts consist of 5 two-choice items, 17 three-choice items, and 8 four-choice items. Examining the items reveals that many, if not all, of these three- and four-choice items can readily be answered correctly without seeing the question. This Type II three-mode analysis indicates that girls did, in fact, respond to the Task 4 items on two different bases—knowing the nonexample and selecting the choice which is different. Idealized person type 1 does well in general but does poorly on Task 4. The idealized person type who does well in general, including doing well on Task 4, shows up in core component 2. This may be clearer if one looks at the persons who score poorly on these two core components. For core component 1 this person does poorly in general except for Task 4 on which she performs well; this is the person who answers Task 4 correctly by selecting the choice which is different. These interactions are a function of the fact that Task 4 was input as a separate factor in the Type II analysis. This was the case since Task 4 formed what was essentially a specific factor for Harris R-S$^2$ in the conventional analyses of the tasks; it was a specific factor for the UMLFA solution. These three-mode results indicate that it would be advisable to revise the Task 4 language arts items so that they consist of just two choices, thus eliminating the possibility that a subject can determine the correct answer without "knowing" the concept. Other minor concept-task interactions for the girls can be seen in Table 17.

Evidently Task 4 did not play a critical role in the results for the boys.

The results for the three-mode factor analyses support the hypothesis that there are no important concept-task interactions for the idealized persons except for Task 4 for the girls for which there is a very probable explanation. Thus is is reasonable to regard these two modes as being independent.

# IV
# Summary and Conclusions

The primary objective of the project entitled "A Structure of Concept Attainment Abilities" is to formulate one or more models or structures of concept attainment abilities, and to assess their consistency with actual data. This paper contains a report of the factor analytic study of the content and task dimensions of the language arts items.

Language arts items to measure concept attainment were developed using a completely crossed design utilizing 30 concepts and 12 tasks. These language arts items were administered during the fall of 1970 to 186 boys and 259 girls who were just beginning the sixth grade.

Two types of total scores were secured from the students' responses to these items—a total score for each of the 30 concepts (totalled across tasks) and a total score for each of the 12 tasks (totalled across concepts). Means, standard deviations, and Hoyt reliability estimates were obtained for each of the 30 concept scores and each of the 12 task scores for each of the groups studied.

Conventional factor analyses were performed separately on the intercorrelation matrices obtained for the concepts and for the tasks for the boys and the girls. Analyses were obtained using three initial factor methods: Alpha (Kaiser & Caffrey, 1965), Harris R-$S^2$ (Harris, 1962), and Unrestricted Maximum Likelihood Factor Analysis (Jöreskog, 1967). Derived orthogonal solutions were obtained for each of the three initial solutions using the Kaiser normal varimax procedure (Kaiser, 1958) and derived oblique solutions were obtained using the Harris-Kaiser independent cluster solution (Harris & Kaiser, 1964).

Three-mode factor analysis (Tucker, 1966a, 1966b) was performed on two different forms of the same data to determine whether there are any important concept-task interactions for the idealized persons.

The conventional factor results for the concepts yielded one or more orthogonal factors for the various methods. The concept variables are almost all of complexity 2, 3, and even greater on these factors, however. The oblique results tend to yield simple structures but the oblique factors are very highly correlated; thus, a main conclusion is that all 30 of the concepts are measures of a single functional relationship existing among the concepts. This holds for both boys and girls.

As with the concepts, the most reasonable interpretation for the tasks is that all 12 of the tasks are measures of a single underlying ability or latent trait. The intercorrelations of the oblique factors are extremely high when more than one factor is yielded.

The results for the three-mode factor analyses support the hypothesis that there are no important concept-task interactions for the idealized persons except for Task 4 for the girls for which there is a very probable explanation. Thus, it is reasonable to regard these two modes as being independent.

The most interesting aspect of studying these language arts items will be to see how they are related to concepts from three other subject matter fields (mathematics, science, and social studies) and to general cognitive abilities. The data for such a study will be collected during summer, 1971. Even though the most reasonable interpretation is that there is only a single common factor for the 30 concepts, the most specific results obtained were used to determine the language arts concepts to be included in the summer, 1971, study. This should permit maximal demonstration of relationships with concepts from other subject matter fields. The two concepts with the highest coefficients on each of the Harris R-$S^2$ factors for both the boys and girls were selected. On this basis a total of 19 language arts concepts were selected for further study.

These concepts are: Compound Word, Consonant, Contraction, Homonym, Silent Letter, Suffix, Synonym, Adjective, Predicate, Present Tense, Question Mark, Sentence, Verb, Details, Explanation, Greeting, Return Address, Title, and Topic Sentence. Even though the most reasonable interpretation for the tasks is that there is a single common factor, all 12 of the tasks will be included in the summer, 1971, study in order to have a reliable concept score (totalled across the 12 tasks for a single concept).

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## Appendix A
## Orthogonal Common Factor Results for Language Arts Concepts: Boys[a]

| Concept | Alpha | Harris R-S² | | | | | | | UMLFA | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A-1 | H-1 | H-2 | H-3 | H-4 | H-5 | H-6 | H-7 | U-1 | U-2 | U-3 |
| Area: Words | | | | | | | | | | | |
| 1 Abbreviation | 81 | 63 | | 36 | | | | | 64 | | 48 |
| 2 Compound Word | 81 | 58 | 37 | | | | | | 62 | 44 | 31 |
| 3 Consonant | 79 | 48 | | | | | | | 54 | 45 | 37 |
| 4 Contraction | 80 | 39 | 34 | | | | | 51 | 51 | 56 | 31 |
| 5 Homonym | 80 | 41 | | 35 | | | 50 | | 48 | 40 | 52 |
| 6 Short Vowel | 80 | 62 | 34 | | | | | | 64 | 36 | 35 |
| 7 Silent Letter | 84 | 57 | | 31 | | | | | 65 | 36 | 41 |
| 8 Suffix | 83 | 46 | | | | | | 38 | 60 | 49 | 32 |
| 9 Synonym | 80 | 43 | 32 | | | | 38 | 35 | 54 | 46 | 37 |
| 10 Word | 84 | 54 | 41 | 31 | | | | | 60 | 46 | 36 |
| Area: Words in Sentences | | | | | | | | | | | |
| 11 Adjective | 78 | | 51 | 33 | | | | | 32 | 73 | 34 |
| 12 Helping Verb | 64 | | 31 | | | | | | | 47 | 37 |
| 13 Period | 80 | 55 | | | | | | | 64 | 40 | |
| 14 Possessive Noun | 76 | | 37 | 40 | | | | 32 | 37 | 52 | 44 |
| 15 Predicate | 70 | 33 | 64 | | | | | | 39 | 59 | |
| 16 Present Tense | 77 | 40 | | 54 | | | | | 41 | 34 | 62 |
| 17 Pronoun | 82 | 32 | 41 | 43 | | | | | 35 | 54 | 57 |
| 18 Question Mark | 83 | 58 | | | 34 | | | | 69 | 37 | 33 |
| 19 Sentence | 84 | 63 | | | | | | | 65 | 35 | 43 |
| 20 Verb | 79 | 35 | 52 | | | | 33 | | 45 | 57 | 34 |
| Area: Connected Discourse | | | | | | | | | | | |
| 21 Comparison | 80 | 36 | 32 | 53 | | | | | 39 | 44 | 60 |
| 22 Details | 80 | 36 | | 57 | | | | | 43 | 36 | 61 |
| 23 Explanation | 74 | 45 | | 47 | | | | | 51 | 32 | 46 |
| 24 Greeting | 78 | 43 | | | | 50 | | | 60 | 38 | 33 |
| 25 Heading | 59 | | | | 53 | | | | 35 | 33 | 34 |
| 26 Paragraph | 84 | 54 | | | | 31 | | | 65 | 42 | 36 |
| 27 Return Address | 73 | 49 | | | | 41 | | | 60 | 35 | |
| 28 Thank You Letter | 81 | 65 | | | | | | | 67 | | 41 |
| 29 Title | 82 | 57 | | 36 | | | | | 59 | 32 | 49 |
| 30 Topic Sentence | 77 | 48 | 41 | | | | | | 55 | 45 | 31 |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

## Appendix B

### Orthogonal Common Factor Results for Language Arts Concepts: Girls[a]

| Concept | Alpha | | Harris R-S[2] | | | | | | | | UMLFA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A-1 | A-2 | H-1 | H-2 | H-3 | H-4 | H-5 | H-6 | H-7 | H-8 | U-1 | U-2 | U-3 | U-4 |
| Area: Words | | | | | | | | | | | | | | |
| 1 Abbreviation | 74 | 43 | 68 | 32 | | | | | | | 67 | 34 | 35 | |
| 2 Compound Word | 68 | 48 | 60 | 34 | 36 | | | | | | 58 | 36 | 40 | |
| 3 Consonant | 66 | 48 | 55 | 34 | | 41 | | | | | 53 | 36 | 45 | |
| 4 Contraction | 60 | 53 | 45 | | 34 | | 31 | | 32 | | 46 | 32 | 62 | |
| 5 Homonym | 70 | 43 | 62 | 33 | | | | | | | 60 | 35 | 38 | |
| 6 Short Vowel | 69 | 48 | 62 | 37 | | | | | | | 61 | 38 | 38 | |
| 7 Silent Letter | 77 | 40 | 73 | 31 | | | | | | | 74 | 33 | | |
| 8 Suffix | 54 | 58 | 42 | 43 | | 39 | | | | | 40 | 46 | 46 | |
| 9 Synonym | 56 | 53 | 46 | 36 | | | | | | | 49 | 44 | 37 | |
| 10 Word | 68 | 50 | 60 | 40 | | | | | | | 61 | 43 | 38 | |
| Area: Words in Sentences | | | | | | | | | | | | | | |
| 11 Adjective | | 75 | | 69 | | | | | | | | 76 | | |
| 12 Helping Verb | 42 | 51 | 32 | 35 | 54 | | | | | | 33 | 37 | 40 | |
| 13 Period | 70 | 43 | 64 | | | | | | | | 63 | 33 | 37 | |
| 14 Possessive Noun | 47 | 63 | 31 | 39 | 37 | 31 | | | | | 32 | 46 | 58 | |
| 15 Predicate | 37 | 65 | 34 | 58 | | | | | | | 34 | 59 | | |
| 16 Present Tense | 58 | 54 | 51 | 44 | | | | | | | 55 | 51 | | |
| 17 Pronoun | 48 | 65 | 42 | 57 | | | | | | | 46 | 62 | | |
| 18 Question Mark | 74 | 39 | 66 | 31 | | | | | | 31 | 61 | | | 49 |
| 19 Sentence | 75 | 42 | 67 | | 31 | | | | | | 68 | 32 | 36 | |
| 20 Verb | 38 | 71 | 36 | 66 | | | | | | | 33 | 63 | | |
| Area: Connected Discourse | | | | | | | | | | | | | | |
| 21 Comparison | 56 | 55 | 47 | 42 | | | | 35 | | | 51 | 49 | 32 | |
| 22 Details | 62 | 56 | 51 | 40 | | | | 35 | | | 53 | 48 | 34 | |
| 23 Explanation | 56 | 53 | 49 | 42 | | | | 40 | | | 55 | 50 | | |
| 24 Greeting | 60 | 45 | 48 | | | | | | | 39 | 42 | 32 | 38 | 47 |
| 25 Heading | 36 | 52 | | 38 | | | 46 | | | | | 42 | 37 | |
| 26 Paragraph | 69 | 47 | 60 | 33 | | 31 | | | | | 60 | 37 | 40 | |
| 27 Return Address | 61 | 31 | 57 | | | | | | | | 54 | | | |
| 28 Thank You Letter | 72 | 39 | 68 | 35 | | | | | | | 66 | 37 | | 37 |
| 29 Title | 68 | 40 | 66 | | | | | | | | 69 | 34 | | |
| 30 Topic Sentence | 54 | 58 | 44 | 41 | | | | | 44 | | 48 | 46 | 44 | |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

## Appendix C
## Orthogonal Common Factor Results for Language Arts Tasks: Boys[a]

| | Task | Alpha | Harris R-S² | | | UMLFA | | |
|---|---|---|---|---|---|---|---|---|
| | | A-1 | H-1 | H-2 | H-3 | U-1 | U-2 | U-3 |
| 1 | Given name of attribute, select example. | 91 | 80 | 48 | | 85 | 43 | |
| 2 | Given example of attribute, select name. | 93 | 72 | 57 | | 62 | 55 | 42 |
| 3 | Given name of concept, select example. | 91 | 77 | 47 | | 65 | 42 | 53 |
| 4 | Given name of concept, select nonexample. | 89 | 66 | 54 | | 56 | 52 | 46 |
| 5 | Given example of concept, select name. | 93 | 66 | 57 | 34 | 53 | 54 | 54 |
| 6 | Given concept, select relevant attribute. | 94 | 60 | 68 | | 47 | 64 | 51 |
| 7 | Given concept, select irrelevant attribute. | 86 | 48 | 73 | | 42 | 75 | |
| 8 | Given definition of concept, select name. | 95 | 63 | 64 | | 52 | 61 | 51 |
| 9 | Given name of concept, select definition. | 91 | 58 | 68 | | 50 | 65 | 40 |
| 10 | Given concept, select supraordinate concept. | 92 | 62 | 59 | 33 | 53 | 58 | 47 |
| 11 | Given concept, select subordinate concept. | 86 | 52 | 60 | 36 | 42 | 57 | 50 |
| 12 | Given two concepts, select relationship. | 84 | 42 | 75 | | 35 | 74 | 33 |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

## Appendix D
## Orthogonal Common Factor Results for Language Arts Tasks: Girls[a]

| Task | Alpha | Harris R-S$^2$ | | | UMLFA | | |
|---|---|---|---|---|---|---|---|
| | A-1 | H-1 | H-2 | H-3 | U-1 | U-2 | U-3 |
| 1 Given name of attribute, select example. | 92 | 51 | 74 | | 46 | 48 | 69 |
| 2 Given example of attribute, select name. | 93 | 62 | 65 | | 60 | 40 | 60 |
| 3 Given name of concept, select example. | 91 | 49 | 71 | 35 | 49 | 53 | 59 |
| 4 Given name of concept, select nonexample. | 88 | 46 | 63 | 45 | 45 | 72 | 42 |
| 5 Given example of concept, select name. | 91 | 60 | 58 | 36 | 62 | 44 | 50 |
| 6 Given concept, select relevant attribute. | 92 | 63 | 63 | | 61 | 38 | 58 |
| 7 Given concept, select irrelevant attribute. | 86 | 69 | 47 | | 67 | 36 | 42 |
| 8 Given definition of concept, select name. | 94 | 66 | 57 | 33 | 68 | 41 | 51 |
| 9 Given name of concept, select definition. | 94 | 67 | 58 | | 68 | 38 | 53 |
| 10 Given concept, select supraordinate concept. | 92 | 65 | 57 | 32 | 65 | 43 | 49 |
| 11 Given concept, select subordinate concept. | 85 | 58 | 47 | 42 | 61 | 48 | 37 |
| 12 Given two concepts, select relationship. | 90 | 71 | 45 | 35 | 74 | 42 | 36 |

[a]Includes those variables which have coefficients greater than .30 (absolute). Decimals have been omitted.

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